HERBST APPLIANCE:
The Timing of Treatment

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Herbst Appliance:
The Timing of treatment

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Herbst Appliance: The timing of treatment

Introduction

In recent years one of the more challenging and investigated areas of orthodontia is the "phenomena" of growth stimulation. This "area" has received increased attention in the last 15 years with regards to the Herbst appliance. The Herbst appliance which is a "bite jumping" appliance (1) has received both praise and criticism in the literature. This "bite jumper" actually positions the mandible in a forward position with no reliance on patient compliance (2). The use of this appliance was first introduced by Emil Herbst in 1905(3) for the correction of Class II anteroposterior relationships. There have been several papers that have evaluated this appliance in the past 2 decades (4-10).

The Herbst appliance corrects Class II malocclusion by (11): 1) decreases maxillary growth (headgear effect) 2) stimulation of mandibular growth 3) stimulation and/or redirection of condylar growth 4) adaptive changes in the glenoid fossa 5) dentoalveolar changes.

With an emphasis on "controlling" the growth of an indivual to correct transverse, anteroposterior and vertical problems as we enter the 21st century it only seems logical to attempt to determine the best time to treat. We have the ability to quantify an individual's growth and maturational level (12) but we often disregard these factors in our treatments. We already know that there are certain timings of craniofacial growth, this paper will attempt to determine and take advantage of these "certain timings".

Purpose

The purpose of this clinically oriented research is to determine the ideal period to utilize the Herbst appliance in the correction of a Class II malocclusion. Maturational levels will be assessed using hand wrist radiographs. My hypothesis is that there is an ideal time (skeletal maturation age) to treat an indivual with the Herbst to take advantage of its effects, and to determine if those effects are primarily skeletal or dental. An adjunct to this research is to possibility to reduce treatment time and/or avoid unnecessary appliance wear.

Materials and Methods

The control group consisted of longitudinal cephalometric radiographs of 12 male and 12 female individuals who participated in the Broadbrent growth studies from 1920 - 1950.

The radiographs were obtained from the Bolton Brush Growth Center at the Case Western Reserve Dental School in Cleveland, Ohio. All of the participants were from Northern European ancestry, had a Class II molar relationship and were not treated orthodontically. A radiograph was obtained corresponding to each of the three skeletal maturation index groups, i.e. SMI 1-3, SMI 4-7, and SMI 8-11.

The experimental group consisted of pre and post cephalometric radiographs of 12 males and 12 females obtained from the private practice office of Dr. Larry Hutta of Columbus, Ohio. All of the experimental subjects were diagnosed with Class II malocclusions and treated with the Herbst appliance. All subjects had corresponding hand wrist films with their lateral cephalometric radiographs. There was some variability of the post treatment radiographs in that some were taken immediately after Herbst removal and some were taken following the termination of full orthodontic treatment.

All of the cephalometric radiographs were traced in the same manner. The following landmarks were utilized:

- ***is- incision superius*** : incisal tip of maxillary left central incisor determined by a tangent perpendicular to OL
- ***ii- incision inferius*** : incisal tip of the mandibular left central incisor determined by a tangent perpendicular to OL
- ***ms- molar superius*** : mesial aspect of the maxillary left 1st molar determined by a tangent perpendicular to OL
- ***mi- molar inferius*** : mesial aspect of the mandibular left 1st molar determined by a tangent perpendicular to OL
- ***A pt*** : junction of the basal and alveolar process in the maxillae determined by a tangent perpendicular to OL
- ***B pt*** : junction of the basal and alveolar process of the mandible determined by a tangent perpendicular to OL
- ***pg- pogoinon*** : the most anterior projection of the bony chin determined by a tangent perpendicular to OL
- ***ar- articulare*** : junction of the temporal bone and the sphenoid
- ***s- sella*** : the center of sella turcica
- ***n- nasion*** : most anterior limit of the frontonasal suture

Measurements:

- is/OLP = position of maxillary central incisor
- ii/OLP = position of mandibular central incisor

- ms/OLP = position of maxillary left 1st molar
- mi/OLP = position of mandibular left 1st molar
- Apt/OLP = position of maxillary jaw base
- pg/OLP = position of mandibular jaw base
- ar/OLP* = length of the mandible
- is/OLP minus ii/OLP = OVERJET
- ms/OLP minus mi/OLP = MOLAR RELATIONSHIP

Angular Measurements:

- Interincisal Angle : angle formed between the maxillary central and mandibular central incisor
- Gonial Angle: angle formed at the junction of the posterior border of the ramus and the lower border of the mandible.
- L1-MP: angle formed between the lower central incisor and the lower border of the mandible.
- U1-PP: angle formed between the upper central incisor and the palatal plane.
- SNA: the angle formed between sella, nasion and A pt.
- SNB: the angle formed between sella, nasion and B pt.
- ANB: the angle formed between A pt, nasion and B pt.

In order to insure a consistent measuring method; nasion and sella were used a reference points. A (NSL) nasion-sella line was used to orientated all head films. Occlusal line (OL) was determined on the initial radiograph along with occlusal line perpendicular(OLP).

Measuring procedure consisted of using OL and OLP from the 1st head film as a reference grid. This grid will was transferred from tracing to tracing by using NSL with sella as the registration point.

To ensure consistent landmark identification, twenty radiographs were retraced by an independent investigator to determiner the error of the method. The intrainvestigator and interinvestigator measurement error was approximately 0.5mm for linear measurements and 0.5* for angular measurements. Percent change estimations were utilized during comparisons of the control and experimental group in order to eliminate differences based upon magnification errors. For all measurement means, standard deviations and difference over time were calculated using (t2-t1)/t1X100. To determine significance of the changes between the control and experimental groups paired and unpaired t-tests were calculated.

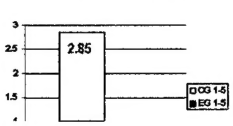
Results:

Incisor A-P position:

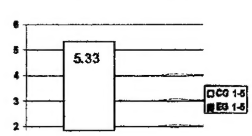
Incisor superius in both control groups; early (SMI 1-5) and late (SMI 6-7) showed a advancement in their A-P position which is consistent with their Class II growth pattern. Both groups showed 2.85% and 5.33% respectively. The experimental groups; early (SMI 1-5) and late (SMI 6-7) showed a significant reduction in the advancement of the incisor superius, .82% and .01% receptively. These differences between the control and experimental groups were statistically significant (<. 05).

The reduction in the advancement of the incisor superius in the experimental groups is consistent with prior research with this appliance. The Herbst seems to have a "head gear" effect on the incisor superius by reducing their a

is/OLP SMI 1-5



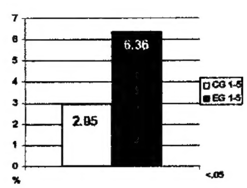
is/OLP SMI 6-7



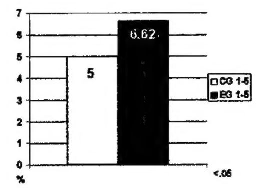
Incisor inferius in both control groups; early (SMI 1-5) and late (SMI 6-7) showed a advancement in their A-P position which is consistent with their Class II growth pattern. Both groups showed 2.95% and 5% respectively. The experimental groups; early (SMI 1-5) and late (SMI 6-7) showed a significant advancement of the incisor inferius, 6.36% and 6.62% receptively. These differences between the control and experimental groups were statistically significant (<. 05).

The increased advancement of the incisor inferius in the experimental groups is consistent with prior research with this appliance. The Herbst seems to move the lower denture base forward as well as procline the incisor inferius which helps to decrease the overjet.

ii/OLP SMI 1-5



ii/OLP SMI 6-7

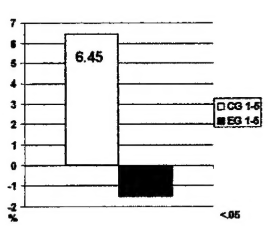


<u>Molar A-P Position:</u>

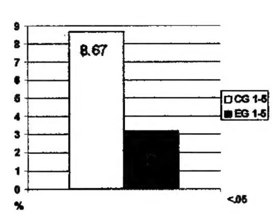
Molar superius in both control groups; early (SMI 1-5) and late (SMI 6-7) showed a advancement in their A-P position which is consistent with their Class II growth pattern. Both groups showed 6.45% and 8.67% respectively. The later SMI group also showed a significant increase compared to the early control group, which is consistent with late mandibular growth. The experimental groups; early (SMI 1-5) and late (SMI 6-7) showed a significant reduction in the advancement of the molar superius, -1.53% and 3.19% receptively. These differences between the control and experimental groups were statistically significant (<. 05).

The reduction in the advancement of the molar superius in the experimental groups is consistent with prior research with this appliance. The Herbst seems to have a "head gear" effect on the molar superius by significantly reducing their advancement. The early SMI experimental group actually showed that the molar superius distalized with this appliance. This could possibly due to the fact that the second molars were unerupted. Another possibility is the early group was in their accelerated growth curve and the "head gear" effect was maximized.

ms/OLP SMI 1-5

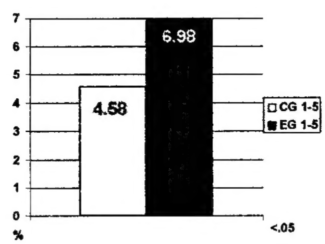


ms/OLP SMI 6-7

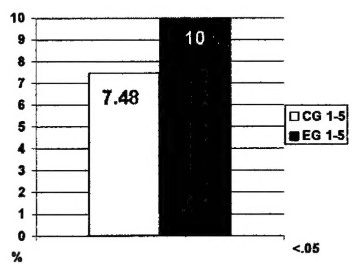


Molar inferius in both control groups; early (SMI 1-5) and late (SMI 6-7) showed a advancement in their A-P position which is consistent with their Class II growth pattern. Both groups showed 4.58% and 7.48% respectively. The experimental groups; early (SMI 1-5) and late (SMI 6-7) showed a significant increase in the advancement of the molar inferius compared to the control groups, 6.98% and 10% receptively. These differences between the control and experimental groups were statistically significant (<. 05). The increased advancement of the molar inferius in the experimental groups is consistent with prior research with this appliance. The Herbst seems to move the lower denture base forward, normal growth was also a factor but the extent is unknown. This increased advancement of the molar inferius and the reduction of forward movement of molar superius helped in the correction of the Class II malocclusion.

mi/OLP SMI 1-5



mi/OLP SMI 6-7

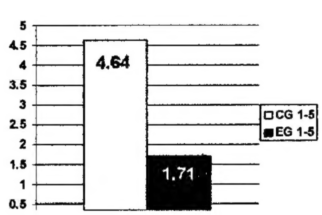


Skeletal A-P Position:

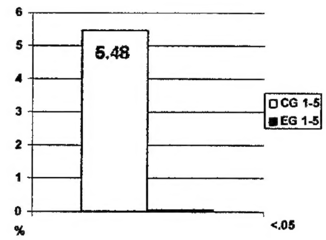
A Point in both control groups; early (SMI 1-5) and late (SMI 6-7) showed a advancement in their A-P position which is consistent with their Class II growth pattern. Both groups showed 4.64% and 5.48% respectively. The experimental groups; early (SMI 1-5) and late (SMI 6-7) showed a significant reduction in the advancement of the A point 1.71% and .06% receptively. These differences between the control and experimental groups were statistically significant (<. 05).

The reduction in the advancement of A point in the experimental groups is consistent with prior research with this appliance. The Herbst seems to have a "head gear" effect on A point by significantly reducing their advancement.

Apt/OLP SMI 1-5

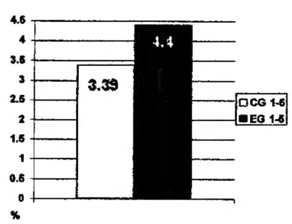


Apt/OLP SMI 6-7

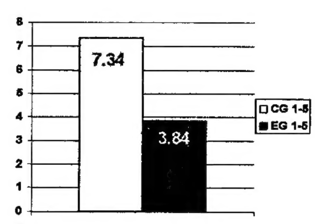


Pogonion: in both control groups; early (SMI 1-5) and late (SMI 6-7) showed an advancement in their A-P position which is consistent with their Class II growth pattern (normal growth). The amount of advancement of pogonion in the controls was out paced by the advancement in A point in the early SMI group, 3.39% to 4.64% respectively. The late SMI group showed that pogonion outpaced A point but it was not significant, 7.34% to 5.48%. The experimental groups; early (SMI 1-5) and late (SMI 6-7) did not show a significant difference in the advancement of pogonion compared to the control groups. These differences between the control and experimental groups were not statistically significant (>. 05).
The increased advancement of pogonion in the experimental groups compared to the controls suggests that the Herbst appliance does not significantly change the position of the chin. This finding is inconsistent with previous research.

pg/OLP SMI 1-5



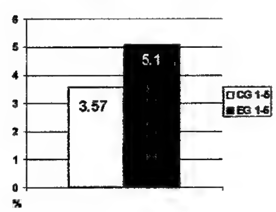
pg/OLP SMI 6-7



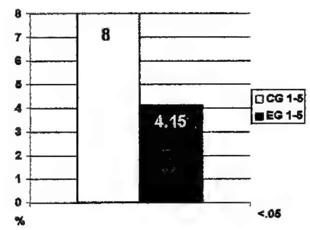
Articulare: in both control groups; early (SMI 1-5) and late (SMI 6-7) showed an advancement in their A-P position which is consistent with their Class II growth pattern (normal growth). The amount of advancement of articulare in the controls was out paced by the advancement in A point in the early SMI group, 3.57% to 4.64% respectively. The late SMI group showed that articulare outpaced A point but it was not significant, 8% to 7.48%. The experimental groups; early (SMI 1-5) did not show a significant difference in the advancement of articulare compared to the control groups, however there was a significant differences in the late SMI (6-7), 8% to 4.14% respectively.

The increased advancement of articulare in the experimental groups compared to the controls suggests that the Herbst appliance does not significantly stimulate growth in the mandible. This finding is inconsistent with previous research.

ar/OLP* SMI 1-5



ar/OLP* SMI 6-7

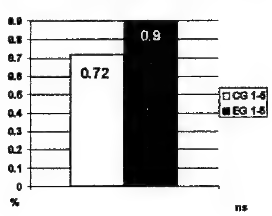


Angular measurements:

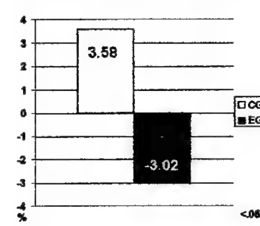
Inter Incisal Angle: in control groups; early (SMI 1-5) and late (SMI 6-7) the inter incisal angle increased .72% and 3.58% respectively. This increase in the inter incisal angle is consistent with past research in Class II growth. . The experimental group, early (SMI 1-5) showed an increase in the inter incisal angle similar to the control group, .9% to .72% receptively. This finding was non-significant. The later SMI (6-7) group showed a decrease in the inter incisal angle of 3.02%. This was a significant finding compared to the control group, -3. 02% to 3.58% respectively.

The decrease in the inter incisal angle in the later group is consistent with previous research and is a result of the "head gear" effect of the Herbst and orthodontics.

Inter Incisal < SMI 1-5

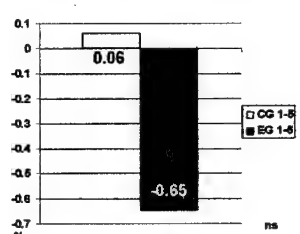


Inter Incisal < SMI 6-7

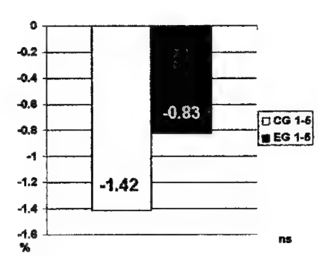


Gonial Angle: The gonial angle decreased in all of the groups except the early (SMI 1-5) of the control

Gonial < SMI 1-5



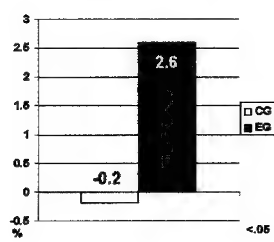
Gonial < SMI 6-7



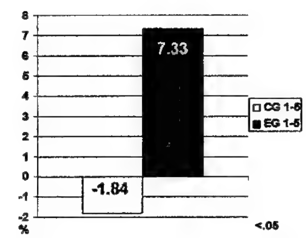
group. This measurement was non-significant for control verse controls experimental verse experimental and control verse experimental. It appears that the Herbst appliance does not effect the gonial angle.

L1-MP: in control groups; early (SMI 1-5) and late (SMI 6-7) the L1 to MP angle decreased -. 2% and – 1.84% respectively. This decrease in the L1 to MP angle is consistent with past research of Class II growth. The experimental groups; early (SMI 1-5) and late (SMI 6-7) showed a significant increase of the L1 to MP angle, 2.6% and 7.33% receptively. This finding is consistent with previous research with the Herbst.
This significant increase in the L1 to MP angle is due to the mesial shift of the mandibular denture. This shift along with the proclination of the lower incisors helps correct the overjet in Class II malocclusions.

L1-MP SMI 1-5

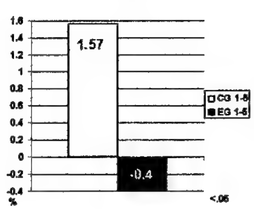


L1-MP SMI 6-7

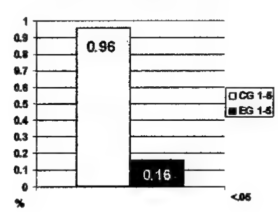


U1-PP: in control groups; early (SMI 1-5) and late (SMI 6-7) the U1 to PP angle increased 1.57% and .96% respectively. This increase in the U1 to PP angle is consistent with past research of Class II growth. . The experimental groups; early (SMI 1-5) and late (SMI 6-7) showed a significant decrease of the U1 to PP angle, -. 4% and .16% receptively. This finding is consistent with previous research with the Herbst.
This significant decrease in the U1 to PP angle is due to "head gear" effect and orthodontic treatment This decrease of the U1 to PP angle helps in the correction of the overjet.

U1-PP SMI 1-5

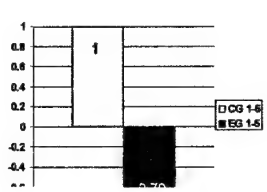


U1-PP SMI 6-7

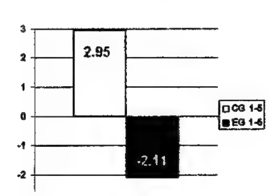


SNA: in both control groups; early (SMI 1-5) and late (SMI 6-7) showed increase in SNA, which is consistent with their Class II growth pattern. Both groups showed 1% and 2.95% respectively. The experimental groups; early (SMI 1-5) and late (SMI 6-7) showed a significant reduction in SNA, -. 79% and –2.11% receptively. These differences between the control and experimental groups were statistically significant (<. 05).
The reduction in SNA in the experimental groups is consistent with prior research with this appliance. The Herbst seems to have a "head gear" effect on A point by significantly reducing its advancement.

SNA SMI 1-5



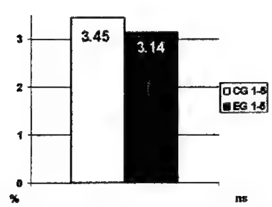
SNA SMI 6-7



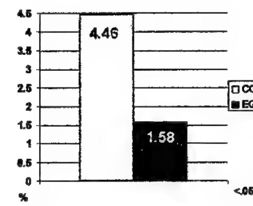
SNB: both the control and experimental groups showed an increase in the SNb angle. In the early SMI (1-5) The control group "out paced" the experimental group, 3.45% to 3.14%. This finding was not significant. The late SMI (6-7) group showed a significant difference in the SNB angle. The control group significantly "out paced" the experimental group, 4.46% to 1.58%. These findings are not consistent with previous research.

The inconsistency may be explained in that the control group subjects at t2 in the late group were much older chronologically compared to the experimental group. Thus the significant difference. The findings in this study fells there is no increase in the projection of the bony chin.

SNB SMI 1-5



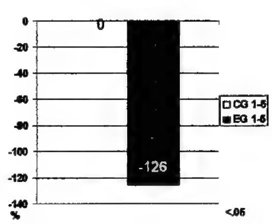
SNB SMI 6-7



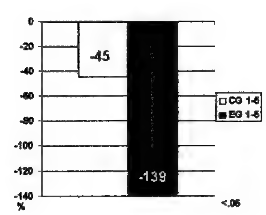
ANB: The ANB angle decreased in all of the groups both control and experimental, except the early SMI (1-5) of the control group that did not show any change. The ANB angle of the early groups SMI (1-5), control and experimental were significantly different, 0% change to –126% respectively. The late SMI (6-7) groups also showed significant differences between the control and experimental, -45% to –139%.

The larger decrease seen in the experimental groups is mostly due to the "head gear" effect of then Herbst appliance and not increased growth of the mandible.

ANB SMI 1-5



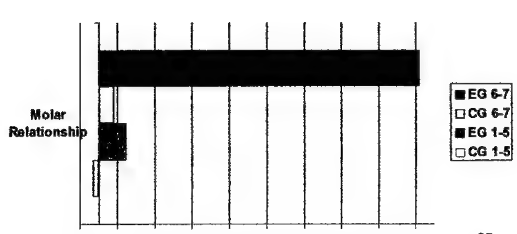
ANB SMI 6-7



Molar Relationship Summary:

- Significant difference in the correction of molar relationship in both experimental groups compared to the control groups.
- Significant difference in the "correction" of the molar relationship between the experimental groups (Early : Late).

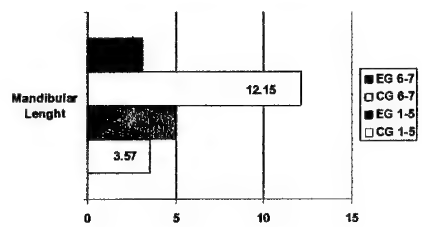
Molar Relationship Summary



Mandibular Length Summary:

- No significant difference between the control and experimental group of the early category.
- There is a significant difference between the groups of the late category . However this may be due to the later SMI's of the control group.

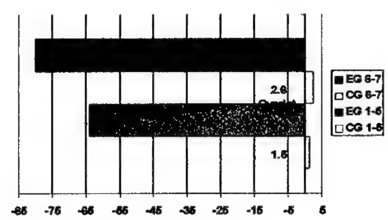
Mandibular Length



Overjet Summary:

- Significant reduction in overjet in both experimental groups compared to the control groups.
- Non-significant reduction in overjet between the experimental groups (Early:Late).

Overjet Summary



Discussion:

An understanding of the skeletal, dental and soft tissue changes is essential in all aspects of orthodontics. This study attempted to evaluate the skeletal and dental changes that are observed with the use if the Herbst appliance. With the data accumulated a attempt to determine if there is a "ideal" time to treat with the Herbst appliance. The majority of the results are consistent with previous research however some of the results are in direct dispute with previous research conclusions.

There is no doubt that the Herbst appliance does correct Class II malocclusions. Past research attempted to give some of the credit of the correction on stimulation of mandibular growth and /or repositioning of the oondyle. This study did not evaluate the position of the condyle, however recent research feels that the condyle may be temporarily repositioned during Herbst therapy but will return to its original position after Herbst removal. The stimulation of growth is also a temporary phenomena with overall net growth being equal to normal growth.

With respect to the findings of this research, the dental findings were the most significant. The maxillary incisors retoclined and did not bodily advance in the Herbst group compared to the controls. The mandibular incisors proclined and shifted bodily forward (proclined more) compared to the controls. These movements of the anterior teeth was the major contributor to the correction of the overjet and not growth of the mandible are the feelings of this researcher.

With regards to the molar relationship the maxillary molars either distalized (Early group) or did not advance as far forward as when compared to the control groups. The mandibular molars shifted forward on the denture base. Again the movement of the teeth on the denture bases is the major corrector of the molar relationship and not stimulated mandibular growth.

Skeletally the most significant finding that helps with the correction of the Class II malocclusion is A point. In the Herbst group A point was significantly "held" back compared to the control groups. This "head gear" effect help redirect maxillary growth and helped with the correction by holding the maxillary incisors and allowing the mandible to "catch" up.

The mandibular measurement showed non significant changes in the position of pogonion between the Herbst group and control group. This illustrates that there is no net gain of mandibular length with the use of a Herbst appliance. Articulare to occlusal line perpendicular measurement was non significant in the early group but a significant change in the late group with the control group growing significantly larger then the Herbst group. This is probably due to the later SMI's in the control group. This again illustrates no increased mandibular growth in the Herbst group.

The Interincisal angle showed more retro inclination in the late Herbst group compared to all other groups. This is probably due to a combination of "head gear" effect and orthodontics. The gonial angle did not show a significant difference in any comparison. This is consistent with previous research in that the Herbst appliance does not effect or is effected by the gonial angle.

The L1-to MP and U1 to PP measurements illustrate the tooth movements that aid in the correction of the overjet, the retroclination of the maxillary incisors and proclination of the mandibular incisors. There seems to be a tendency for more proclination in the lower incisors in the later Herbst group, and a tendency for more retroclined maxillary incisors in the early Herbst group.

The measurements SNA, SNB, ANB were all consistent with the correction of a Class II malocclusion. SNA decreased in both Herbst groups compared to the controls. SNB Moved anteriorly due to natural growth and ANB decreased. The ANB angle decrease due to the "head gear" effect on A point and the natural forward growth of the mandible.

Conclusion:

To answer our primary question is there an ideal time to treat with the Herbst appliance? The answer according to the results of this research is there a no "large scale" treatment benefits between the early Herbst group and the late Herbst group. It is recommended from this research in accordance with past research and clinical success to treat in the later SMI group. This recommendation is due to the increased retention of the correction of the

Class II. This is accomplished by the interdigitation of the permanent occlusion. There may also be better patient cooperation and tolerance.

There are "large scale" differeces between the control groups and the Herbst groups within their respective SMI group. These differnces indicate the correction of a Class II malocclusion into a Class I. The correction seems to be primarily dental in origin, there seemed to be no increase in the length of the mandible.

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